Measuring the Burden of Disease: Healthy Life-Years

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ABSTRACT

Objectives. This paper presents the background and rationale for a composite indicator, healthy life-year (HeaLY), that incorporates mortality and morbidity into a single number. HeaLY is compared with the disability-adjusted life-year (DALY) indicator, to demonstrate the relative simplicity and ease of use of the former.

Methods. Data collected by the Ghana Health Assessment team from census records, death certificates, medical records, and special studies were used to create a spreadsheet. HeaLYs lost as a result of premature mortality and disability from 56 conditions were estimated.

Results. Two thirds of HeaLYs lost in Ghana were from maternal and communicable diseases and were largely preventable. The age weighting in DALYs leads to a higher value placed on deaths at younger ages than in HeaLYs. This spreadsheet can be used as a template for assessing changes in health status attributable to interventions.

Conclusions. HeaLYs can aid in setting health priorities and identifying disadvantaged groups. The disaggregated approach of the HeaLY spreadsheet tool is simpler for decision makers and useful for country application. (*Am J Public Health.* 1998;88:196–202)

Introduction

Rationing of health care resources is a fact of life; in every country, choices of how best to use resources for health must be made.[1] The severe resource limitations in developing countries make it even more important than in technically advanced countries to ensure that resource allocation choices lead to the most health for the money.[2] In recent years, approaches have been developed that are designed to measure health status by use of composite indicators incorporating morbidity and mortality into one number.[1–6] These indicators have not yet been forged, however, into practical tools that decision makers can readily use to assist them in making better choices for health spending. This paper presents the first steps toward development of such a tool.

The principal reason for attempting to capture the complex mix of incommensurate consequences resulting from disease into a single number is the need to weigh the benefits of health interventions against their costs. Costs of health programs are expressed in a unidimensional measure, namely dollars; therefore, the benefits to be achieved from their expenditure must also be so expressed.

The purposes of this paper are to modify and further explicate the original formulation of healthy life lost or gained developed by the Ghana Health Assessment team[7] and to reformat the original data as a template for a spreadsheet tool for use in resource allocation decisions. We believe that the formulation described in this paper is simpler and more flexible, transparent, and understandable than disability-adjusted life-years (DALY)[1,6] and that it can be used quite directly to assist decision makers. We also compare the reformulated healthy life-years (HeaLYs) from the Ghana data with the DALYs for sub-Saharan Africa presented in the *World Development Report.*[1]

Methods and Conceptual Basis for the Healthy Life-Year

The 2 effects of diseases in a population are morbidity and mortality; other consequences are directly related to these effects. These consequences include pain, suffering, fear, and dread; loss of working time and income; worry, anxiety, and breakup of families; disruptions in the life and welfare of the community; and costs of care, coping, and prevention. The HeaLY is a composite measure that combines the amount of healthy life lost due to morbidity with that attributable to premature mortality. It can be applied to individuals or to population groups to determine the impact of a particular disease, to work out the effects of an intervention, or to compare areas, populations, or socioeconomic groups.

This approach uses the pathogenesis and natural history of disease[8] as the conceptual framework for assessing morbidity and mortality and for interpreting the effects of various interventions. We have defined disease in the clinical sense to designate an individual who has symptoms or signs of, literally, *dis-ease*. With some exceptions, those with infection or a certain biological characteristic such as sickle cell trait (AS) hemoglobin are considered healthy unless or until they have specific identifiable symptoms or signs. Preclinical or subclinical disease is not generally counted.

However, the diagnostic criteria for certain conditions (e.g., HIV infection or onchocerciasis diagnosed by skin snip) include individuals without signs or symptoms. Such criteria (e.g., indicators of infection, high blood pressure, or genetic markers) are appropriate when they serve as the basis for intervention programs. Interventions may also be directed at reducing identifiable risk factors such as tobacco smoking or risky sexual behavior. To the extent that risk reduction can be translated into disease reduction, the approach to measuring the benefits and costs of a risk reduction intervention program remains the same.

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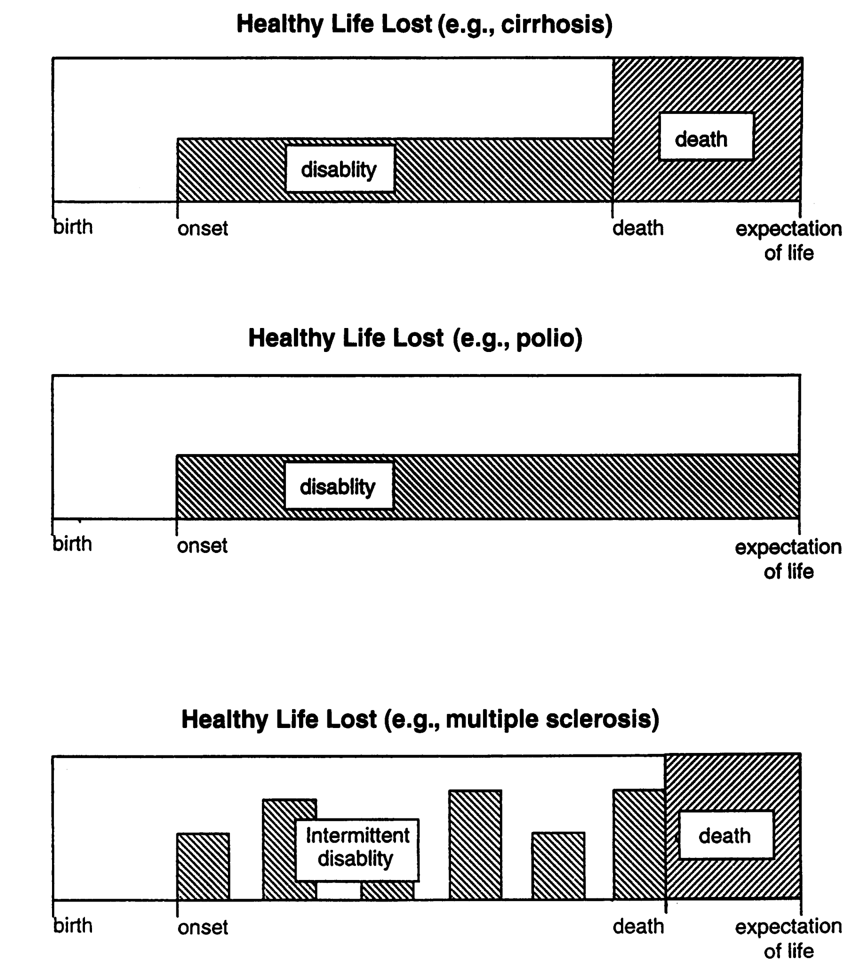

FIGURE 1—Different patterns of healthy life lost.

The onset of disease usually will be dated from the start of symptoms or signs as determined by the individual afflicted, a family member, or a medical practitioner, or as the result of a laboratory test. Termination of a disease state may be by recovery, by death, or by progression to another disease. There are several different patterns of disease evolution; Figure 1 illustrates healthy life lost from disability and from premature death due to typical cases of cirrhosis, polio, and multiple sclerosis in terms of onset, extent, and duration of disability and termination.

Information needs, definition of variables, and formulas to calculate HeaLYs are given in Table 1. For most diseases, the natural history is determined at onset; therefore, the amount of healthy life lost due to premature mortality should be based on the expectation of life at onset rather than the expectation of life at death. Expectation of life, based on normative expectations of what should be achieved under optimal circumstances and approximated in Japan, has been taken from regional low mortality model life tables with a life expectancy at birth of 82.5 years for females.[9,10]

The three components of measuring loss due to disability are included in Table 1. The case disability ratio and the duration of disability can generally be determined objectively, but the extent of disability has a subjective component. The many forms of disability, including pain, discomfort, loss of function, and emotional effects, make it a multidimensional concept; a composite indicator must reduce these many dimensions to a unidimensional scale to make disability comparable to loss of healthy life from premature mortality.[7,11] The disability severity scale used was developed largely by expert opinion and a group consensus process by the Ghana Health Assessment team. Team members, in collaboration with selected community members and clinicians from the University of Ghana Medical School, scored extent of disability for specific diseases into broad categories of about 25% each (0.00 for no disability, 1.00 for disability equivalent to death). For example, the scale ranks the loss of one limb as 0.25 disabled and the loss of two limbs as 0.50 disabled, as is commonly done by disability insurance companies. By keeping the categories broad, the team generally came to a reasonable consensus. These scores represent an estimate of the average disability suffered in typical cases of the specific disease over its course.

Each disease will have a distribution of ages at which onset or death may occur; for most diseases, however, the average age will provide a satisfactory approximation. If sensitivity testing[12] indicates that the average age is not satisfactory, then calculations can be based on age distributions. In recurrent diseases or diseases with multiple episodes (e.g., diarrhea), age at onset denotes the average age at the first episode. It was useful to view some diseases (e.g., malaria, which is characterized by frequent reinoculation, and schistosomiasis, in which reinfection occurs at frequent intervals) as single lifetime diseases. Thus, malaria was considered for each individual as a single, lifelong disease with chronic, usually asymptomatic parasitemia but involving intermittent severe clinical attacks with high mortality in late infancy and early childhood while immunity is being acquired, followed by recurring, mild clinical episodes with virtually no mortality after 10 years of age.

The healthy life lost attributable to incident cases in a given year includes the stream of life lost due to premature death or disability in future years as well as in the current year. The health status of a population is determined by the amount of healthy life it achieves as a proportion of the total amount that the people could achieve under optimum conditions. A cohort of 1000 newborns with a life expectancy of 82.5 years has the potential for 82 500 years of healthy life. In a steady state, a random sample of 1000 from such a population has the potential for 41 250 years of healthy life.[3] Each year, this population would experience events leading to 1000 years of healthy life lost attributable to mortality, with a distribution of age at death equivalent to that leading to a life expectation of 82.5 years at birth. Any disease that leads to disability or to death at a point earlier than that set by this age-at-death distribution would increase the amount of healthy life lost beyond this minimum. Discounting future life or adding productivity, dependency, or age weighting would affect these denominators.

TABLE 1—Variables for Healthy Life-Years (HeaLY) Estimation

Sign	Explanation	Expression
I	Incidence rate per 1000 population per year	Per 1000 per year
Ao	Average age at onset	Years
Af	Average age at death	Years
E(Ao)	Expectation of life at age of onset	Years
E(Af)	Expectation of life at age of death	Years
CFR	Case fatality ratio: proportion of those developing the disease who die from the disease	0.00–1.00
CDR	Case disability ratio: proportion of those developing the disease who have disability from the disease	0.00–1.00
De	Extent of disability (from none to complete disability equivalent to death)	0.00–1.00
Dt	Average duration of disability for those disabled by the disease; a composite of temporary and permanent disability based on the proportion of cases in each category	Years
HeaLY	Healthy life years lost per 1000 population per year: $I \times \{[CFR \times \{E(Ao) - [Af - Ao]\}] + [CDR \times De \times Dt]\}$	HeaLYs per 1000 per year

In calculating HeaLYs, 2 value judgments were made. First, life lived at any age was valued equally; for example, a year of life lived at age 25 had the same value in this study as a year of life lived at age 65. Second, the measure of time lost (expectation of life lost due to mortality and the duration of disability) was discounted at a rate of 3% per annum. Data analysis for HeaLYs was conducted via several interlinked spreadsheets in Microsoft Excel 7.0, with the variables described earlier. (This Excel 7.0 Windows spreadsheet is available by sending a formatted diskette with a self-addressed return envelope, suitable for mailing discs, with postage to the authors.)

The Ghana Data Set

The Ghana data set is a cohesive, comprehensive national data set that remains unique in Africa.[7,13,14] Age-, sex-, and region-specific mortality rates for the entire country were derived from a 1-year post-census, 5% sample of enumeration areas. This was combined with an analysis of all 1975 death certificates (which were available for about 12% of total deaths but biased toward deaths occurring in major hospitals in the south of Ghana, which in turn were biased toward better educated, middle-class young and middle-aged adults) categorized by underlying cause of death in accordance with a modified B list from the eighth revision of the *International Statistical Classification of Diseases, Injuries and Causes of Death.*[15] An estimate for AIDS was added on the basis of 1990 data, but the loss was not counted in the totals and is provided for illustrative purposes only. Further information was obtained from inpatient records, especially from Korle Bu, the major teaching hospital in Accra; the medical field units of the Ministry of Health, and a variety of special studies, many unpublished, from teaching and mission hospitals. Weaknesses and approaches to accommodating the known biases were noted in the original report and its list of supporting documents (available by sending a self-addressed return envelope with postage to the authors). This data set reflects the health status of Ghana's population (1976 through 1981) with the health system in operation. It was estimated that health services of a modern, Western nature were available and made use of by about 30% of the population overall.

Results

The input variables and the number of healthy life-years lost in Ghana for each disease category are listed in order of discounted HeaLYs in Table 2. Overall, 1345.90 HeaLYs (not discounted) per 1000 people were lost as a result of new cases of disease in a year. When expectation of life and duration of disability were discounted, loss of healthy life equated to 595.21 discounted HeaLYs per 1000 people.[6,16] Malaria and measles caused the greatest loss of healthy life; 40 conditions each resulted in a loss greater than 1 healthy life-year per 1000. Discounting has differential effects on diseases: cerebrovascular disease and tuberculosis, which mainly affect adults, shifted up in the rankings relative to childhood diseases such as measles and malnutrition.

In Table 3, the 15 leading causes of discounted HeaLY loss in Ghana are compared with DALY losses estimated for sub-Saharan Africa[17] in comparable disease categories. Even though the DALY losses covered all countries in sub-Saharan Africa, the time periods were a decade apart, and the data sources and methods of calculation were different, the list of conditions and their relative rankings are generally similar. Some differences are due to different classifications, while others reflect genuine differences in disease occurrence. For example, the reason for the large difference in injuries is that the sub-Saharan Africa data included effects of war and intentional violence, major problems in some parts of Africa but not in Ghana. Measles was much more prominent in Ghana because measles immunization was just being introduced at the time; it would be much less prevalent now. Also, the Ghana data were based on a complete review of all deaths in one country at one time, whereas the DALY[17] data were assembled mostly by expert opinion and have not been subject to the same sorts of internal constraints such that total deaths by age, sex, and region were known and counted only once. For example, there was a greater than fourfold difference in cerebrovascular disease (which accounted for

TABLE 2—Loss of Healthy Life-Years (HeaLYs) per 1000 per Year in Ghana, by Disease (1981)

Disease	I	CF	Ao	Af	E(Ao)	CD	De	Dt	HeaLY	Dis HeaLY[a]
Malaria	40.00	0.02	1	1	81.84	1.00	0.90	1.48	128.40	47.81
Measles	39.00	0.03	1	1	81.84	1.00	0.75	0.06	97.46	37.35
Sickle cell	1.25	0.80	0	5	82.50	1.00	0.30	20.50	85.19	35.82
Birth injuries	1.60	0.50	0	0	82.50	1.00	0.25	41.25	82.50	33.89
Prematurity	9.60	0.10	0	0	82.50	0.10	0.25	8.25	81.18	31.06
TB	2.00	0.50	20	25	63.08	1.00	0.50	2.77	60.85	30.16
Injuries	7.70	0.10	15	15	68.02	1.00	0.30	3.39	60.21	29.78
ALRI (child)	2.40	0.40	2	2	81.84	1.00	0.90	0.05	78.67	29.36
Malnutrition	1.50	0.60	2	2	81.84	1.00	0.90	0.20	73.92	27.69
Cerebrovascular	2.30	0.35	50	50	33.99	1.00	0.40	11.78	38.20	26.28
Severe diarrhea	70.00	0.01	1	1	81.84	1.00	0.90	0.04	59.78	23.82
ALRI (adult)	7.00	0.10	30	30	53.27	1.00	0.90	0.07	37.74	19.07
Cirrhosis	0.65	0.80	30	35	53.27	1.00	0.25	14.65	27.48	15.19
Hypertension	0.75	0.75	40	50	43.53	1.00	0.25	18.38	22.31	14.54
Tetanus neonate	0.50	0.80	0	0	82.50	1.00	0.90	0.02	33.01	12.22
Typhoid	4.00	0.10	20	20	63.08	1.00	0.90	0.11	25.62	11.71
Cancer (adult)	0.65	0.80	50	52	33.99	1.00	0.75	1.70	17.46	11.50
Congenital malformation	0.96	0.15	0	0	82.50	1.00	0.25	70.12	28.71	11.42
Hernia/Intestinal obstruction	4.00	0.10	30	40	53.27	0.20	0.10	11.65	18.24	10.48
Schistosomiasis	7.00	0.04	5	30	77.95	1.00	0.01	75.83	20.13	9.52
Pregnancy complications	4.80	0.07	20	20	63.08	0.05	0.25	3.20	19.87	9.02
Hepatitis	8.87	0.03	20	20	63.08	1.00	0.90	0.16	18.02	8.77
Other HD	0.37	0.75	35	45	48.38	1.00	0.30	19.59	12.83	7.97
Other GI	2.80	0.10	25	25	58.17	1.00	0.50	0.14	16.49	7.90
Pertussis	21.00	0.01	1	1	81.84	1.00	0.90	0.08	18.68	7.89
Tetanus	0.75	0.35	15	15	68.02	1.00	0.90	0.05	17.89	7.65
Chronic renal	0.31	0.85	30	35	53.27	1.00	0.25	12.24	13.67	7.51
Meningitis	1.25	0.20	10	10	72.99	1.00	0.90	0.06	18.32	7.47
Peptic ulcer	3.88	0.02	25	35	58.17	1.00	0.05	57.21	14.84	7.28
Rheumatic HD	0.30	0.75	25	32	58.17	1.00	0.30	19.79	13.29	7.23
Birth pneumonia	0.46	0.50	0	0	82.50	1.00	0.00	0.08	18.98	7.02
Umbilical sepsis	0.22	1.00	0	0	82.50	1.00	0.00	0.00	18.15	6.72
Leprosy	0.50	0.25	20	30	63.08	1.00	0.25	49.81	12.86	6.55
Mental disorders	0.66	0.05	15	35	68.02	1.00	0.30	65.62	14.58	6.52
Hemolytic	0.14	1.00	0	0	82.50	1.00	0.00	0.00	11.55	4.27
Dental	2.80	0.00	10	0	72.99	1.00	0.15	7.30	3.07	2.75
Gynecological	1.00	0.01	25	40	58.17	1.00	0.25	11.78	3.38	2.72
Congenital HD	0.07	0.80	0	10	82.50	1.00	0.30	24.50	4.57	2.02
Polio	0.22	0.05	3	3	81.84	1.00	0.25	77.75	5.18	1.99
Yaws	6.00	0.00	4	0	81.84	1.00	0.30	0.82	1.47	1.46
Hookworm	19.00	0.001	4	5	81.84	0.05	0.06	4.09	1.77	0.80
Diabetes	0.05	0.50	40	55	43.53	1.00	0.25	29.27	1.08	0.72
Cancer (child)	0.03	0.75	6	7	77.95	1.00	0.90	0.87	1.75	0.70
Chickenpox	22.00	0.0002	4	4	81.84	1.00	0.50	0.04	0.80	0.57
Ear, nose, throat	0.56	0.003	12	25	72.99	1.00	0.25	2.96	0.51	0.44
Cataracts/eye	0.05	0.00	60	0	24.83	1.00	0.50	24.83	0.62	0.44
Trypanosomiasis	0.05	0.19	15	17	68.02	1.00	0.30	9.52	0.77	0.40
Skin infections	470.00	0.00	4	0	81.84	1.00	0.05	0.02	0.38	0.38
Onchocerciasis	2.80	0.00	5	0	77.95	0.05	0.70	3.90	0.38	0.36
Trachoma	1.60	0.00	3	0	81.84	0.05	0.86	4.21	0.29	0.27
Guinea worm	2.40	0.00	7	0	77.95	1.00	0.90	0.12	0.26	0.26
Common cold	1000.00	0.00	15	0	68.02	1.00	0.10	0.02	2.00	0.20
Cholera	0.05	0.10	15	15	68.02	1.00	0.90	0.05	0.34	0.15
STD	4.25	0.0001	20	30	63.08	1.00	0.25	0.10	0.13	0.12
Diptheria	0.01	0.07	3	3	81.84	1.00	0.90	0.07	0.06	0.02
Total									1345.90	595.21
AIDS	0.85	1.00	20	25	63.08	1.00	0.50	5.00	51.49	25.35

Note. I = incidence (per 1000 per year); CF = case fatality (0.00–1.00); Ao = age at onset (years); Af = age at death (years); E(Ao) = expectation at onset (years); CD = case disability (0.00–1.00); De = disability extent (0.00–1.00); Dt = disability duration (years). ALRI = acute lower respiratory infection; HD = heart disease; GI = gastrointestinal; STD = sexually transmitted diseases. Data were derived from Ghana Health Assessment Team, 1981.
[a]Discounting of E(Ao) and Dt at 3% per annum.

TABLE 3—Leading Causes of HeaLY (Ghana, 1981) and DALY (Sub-Saharan Africa, 1990) Loss (per 1000 per year)

Rank	Disease	HeaLY Loss	(%)[a]	Rank	Disease	DALY Loss	(%)[a]
1	Malaria	47.81	(8.03)	1	Malaria	61.74	(10.77)
2	Measles	37.35	(6.28)	2	Diarrhea	59.49	(10.37)
3	Sickle cell disease	35.82	(6.02)	3	ALRI	59.88	(10.44)
4	Birth injuries	33.89	(5.69)	4	Injuries	53.56	(9.34)
5	Prematurity	31.06	(5.22)	5	Perinatal diseases	40.92	(7.14)
6	TB	30.16	(5.07)	6	HIV	35.98	(6.27)
7	Injuries	29.78	(5.00)	7	Measles	31.45	(5.48)
8	ALRI (child)	29.36	(4.93)	8	TB	26.83	(4.68)
9	Malnutrition	27.69	(4.65)	9	Cardiovascular	24.01	(4.19)
10	Cerebrovascular	26.28	(4.42)	10	Neuropsychiatric	19.13	(3.34)
11	HIV/AIDS	25.35[b]	...	11	Nutritional	15.83	(2.76)
12	Severe diarrhea	23.82	(4.00)	12	Maternal conditions	15.66	(2.73)
13	ALRI (adult)	19.07	(3.20)	13	STDs	14.63	(2.55)
14	Cirrhosis	15.19	(2.55)	14	Congenital abnormalities	12.43	(2.17)
15	Hypertensive HD	14.54	(2.44)	15	GI disorders	10.79	(1.88)
	Subtotal	401.82	(67.51)		Subtotal	482.33	(84.10)
	Others	193.39	(32.49)		Others	91.18	(15.90)
	All	595.21	(100.00)		All	573.51	(100.00)

Note. Data were derived from Murray and Lopez.[17] ALRI = acute lower respiratory infection; HD = heart disease; STDs = sexually transmitted diseases; GI = gastrointestinal.
[a]Percentage of total burden.
[b]1990; not counted in totals.

8.37 of the 24.01 DALYs per 1000 in the cardiovascular disease category) and a nearly twofold difference in malnutrition in terms of percentage of loss attributed to these causes. It should be noted that loss from malnutrition was considered relatively undercounted in the Ghana data.

The *World Development Report*[1] divided diseases into three groups: group I (communicable, maternal, and perinatal diseases), group II (chronic and noncommunicable diseases), and group III (accidents and injuries). Regrouping of the Ghana data revealed the following discounted HeaLY losses per 1000 per year: 417.53 for group I (70.15%), 147.90 for group II (24.85%), and 29.78 for group III (5.00%). Comparable DALY values for sub-Saharan Africa were 409.06 (71.33%), 110.82 (19.33%), and 53.56 (9.39%), respectively.[17]

To examine differential effects of the DALY construct as compared with the HeaLY, we applied the DALY formulation to the Ghana data. Since the *World Development Report*[1] used a different disability severity scale,[11] only loss of healthy life from death was used to compare HeaLYs and DALYs. The rankings were similar, of course; however, for all diseases of childhood, the DALYs were differentially valued at higher levels, whereas those with onset after 25 years of age were less than for HeaLYs. A total of 517.79 discounted HeaLYs per 1000 population were lost from premature death, as compared with 568.30 discounted DALYs per 1000. The reason for this differential effect is shown in Figure 2, which compares loss of discounted DALYs and HeaLYs according to age at death.

Discussion

The HeaLY formulation is based on the original Ghana construct,[7,13] but important changes have been introduced. The expectation of life is based on a normative concept of the healthy life that a person should achieve with present knowledge and access to modern health care, as captured in the West model 26 life table[9] rather than that based on Ghana's life table. Disability parameters have been standardized for both the severity and duration components to make them more consistent. Discounting at 3% per year is added and affects life expectancy and duration of disability. HeaLYs are expressed in years rather than days. Although we have used the same information as in the original Ghana work, we recognize that estimates for recent years for several diseases would need to be changed. The considerable improvements in health services and extension of coverage have also altered the burden of disease.

There are several differences in this approach from the DALY version formulated in the Global Burden of Disease Study.[1,17,18] Discounting is done separately rather than being integrated into the formula. No differential is given to the value of life according to the age at which life is lived. Figure 2 shows that valuing life at different ages, as in DALY, leads to a greater loss of life in the young than does valuing life equally at all ages. Two differences in Ghana mortality analyses are noteworthy: (1) diseases that afflict the young receive more weight in the DALY formulation than in the HeaLY approach, and (2) total DALYs are more than total HeaLYs. The reason for both effects is that the DALY construct values life lost in the young relatively more than does the HeaLY construct. This seems counterintuitive, since the DALY was constructed specifically to give greater weight to life lived by adults in their productive years than to life lived during the ages of dependency at either end of the age spectrum. The higher weighting at younger ages in the DALY, as compared with the HeaLY, is due to the cumulative addition of life expectation, as can be seen in Figure 2. This phenomenon was also recently pointed out by Barendregt et al.[19]

In the HeaLY formulation, healthy life lost is based on all diseases with onset in a given year and on the stream of life lost due to disability and death thereafter in accordance with the natural history of disease. In the DALY formulation, disability is calculated in an equivalent fashion but termed "life lived with disability," whereas mortality is considered for all deaths in the current year regardless of when onset occurs. In practice, this makes little difference in a steady state, since expectation of life is cal-

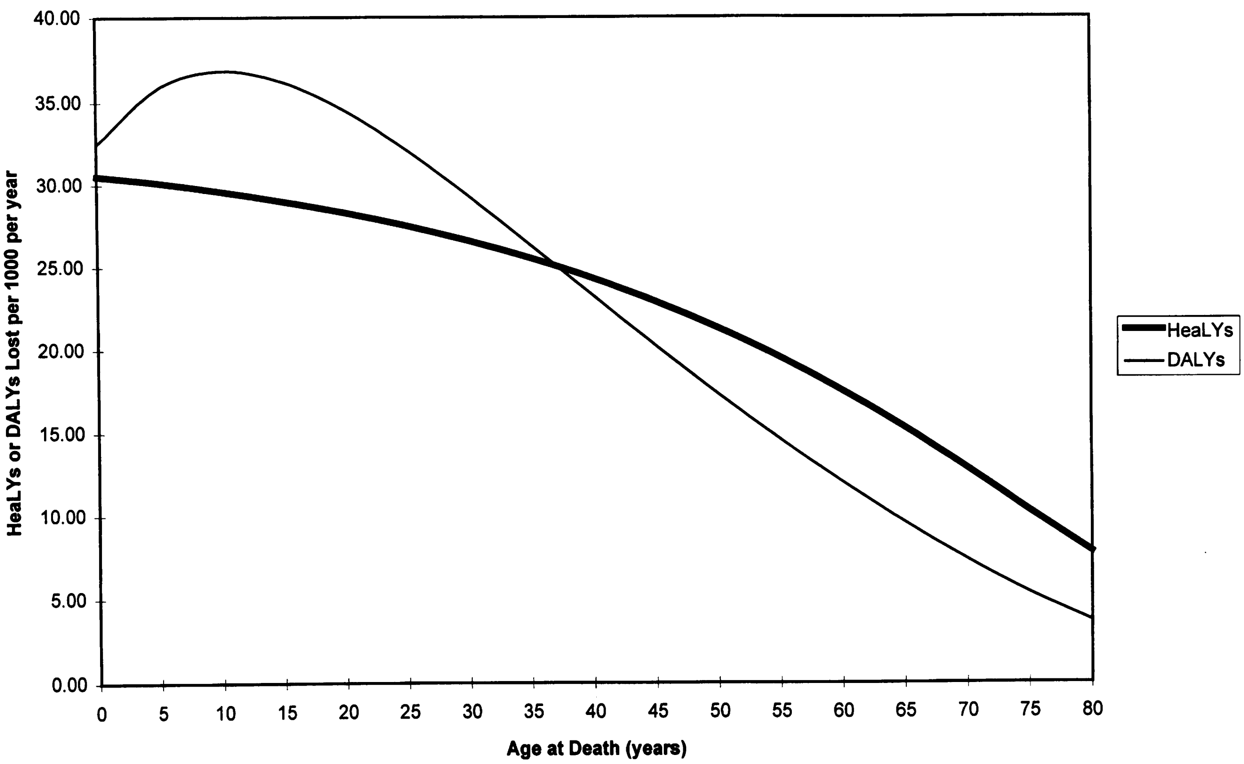

FIGURE 2—Comparison of discounted HeaLYs and DALYs lost from premature mortality, by age at death.

culated on the basis of current estimates of age-specific mortality. HeaLYs use expectation of life from disease onset rather than the expectation of life at death, again in keeping with the natural history of disease; this results in slightly less loss attributed to the HeaLY proportional to the duration between onset and death, but even with a long interval the effect is minor.

A potential concern might be that using life expectation to calculate life lost gives undue weight to the death of a child as compared with the death of an adult. However, this approach is appropriate if the objective is to maximize the total healthy life of the population. The approach can be modified in a number of ways to give different weights to different ages or values added for productivity or subtracted for dependency,[16] each of which may lead to differences in relative rankings of diseases. This was done in the *World Development Report*, in which an exponential function was chosen to assign different relative values of life lived at different ages.[1]

Except for extent of disability, objective data for the other variables involved in this approach potentially could be obtained. Although assessment of the extent of disability has important subjective components, a reasonable consensus has been achieved both in the work from Ghana[7] and for DALYs[11] by using relatively broad ranges for extent of disability. In developing countries, where so much of the loss of healthy life is due to early death, the relatively crude distinctions in incremental ranges of 10% to 25% levels of disability are generally useful. However, in technically advanced countries where a high prevalence of chronic disability constitutes a larger proportion of healthy life lost, improving the methodology for distinguishing finer gradations among chronic disabilities becomes important.

Comorbidity has not been directly addressed, but the presence of multiple diseases simultaneously, which is common in developing countries, may have important effects on both mortality and disability. Attributing healthy life lost to a particular cause can be challenging. For example, the death of a mother increases the risk of death among her dependent children, and therefore the healthy life-years lost from her children's deaths could be attributed to the cause of her death. Such interdependence has not been incorporated in this study. However, attributing loss to specific diseases is not the main issue; rather, the major purpose of the HeaLY formulation is assessment of the effects of health interventions, some of which may have an impact on more than one disease.

A major limitation of these methods (HeaLY and DALY) is that the information required is not readily available in developing countries.[20] For most countries, estimates of data based on extrapolation and creative epidemiological methods using the local data that are available will have to suffice.[20] Sensitivity analysis[12] should be an integral component of data analysis to determine what information is required to improve decisions. Innovative approaches are needed for obtaining better health status data than are currently available and, particularly, for relating changes in health status attributable to interventions; special epidemiological approaches in selected sentinel areas may be a useful approach.

The value of the DALY formulation for rapidly making multiple comparisons in a standardized fashion has been well documented by the global comparisons in the *World Development Report*[1] and the Global Burden of Disease Study,[18] but it has been cumbersome to use for cost-effectiveness comparisons of alternative interventions. The HeaLY approach is simpler and more flexible for this purpose and for including local data and values. Changes in incidence from preventive measures, or changes in case fatality or disability from treatment procedures and alterations in coverage, can be directly incorporated into the spreadsheet. The spreadsheet described in this paper is the first step toward development of a tool to assist in making better choices in health resource allocation. The further steps under way are to add in the expected effects of specific interventions (or packages of interventions) for each disease and an approach to obtaining the unit costs of the interventions. □

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